General

Guideline Title

Practice advisory on anesthetic care for magnetic resonance imaging: an updated report by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging.

Bibliographic Source(s)

American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Practice advisory on anesthetic care for magnetic resonance imaging: an updated report by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Anesthesiology. 2015 Mar;122(3):495-520. [146 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging, Ehrenwerth J, Singleton MA, Bell C, Brown JA, Clark RM, Connis RT, Herfkens R, Litt L, Mason KP, McClain CD, Nickinovich DG, Ryan SM, Sandberg WS. Practice advisory on anesthetic care for magnetic resonance imaging. A report by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Anesthesiology. 2009 Mar;110(3):459-79. [130 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Zone definitions (III–IV) are provided at the end of the "Major Recommendations" field.

Summary of Recommendations

I. Education
- All anesthesiologists should have general safety education on the unique physical environment of the magnetic resonance imaging (MRI) scanner and specific education regarding the specific features of individual scanners within their institution.
  - Education should emphasize safety for entering zones III and IV, with special emphasis on hazards in this environment and effects on monitoring capabilities.
  - Education should address potential health hazards (e.g., high decibel levels and high intensity magnetic fields).
  - Education should address necessary precautions to deal with the specific field strength and the safety of the MRI scanners within their institutions.
  - Education should include information regarding ferromagnetic items (e.g., stethoscopes, pens, wallets, watches, hair clips,

name tags, pagers, cell phones, credit cards, and batteries) and implantable devices (e.g., spinal cord stimulators and implanted objects) that should not be brought into zones III and IV of the MRI suite or should be brought in with caution.

- Anesthesiologists should work in collaboration with radiologists, technologists, and physicists within their institutions to ensure that the above topics are included in their safety training programs.
- Education should include how to safely respond to code blue situations in zones III and IV, and this information should be integrated into protocols for the designated code blue team.

II. Screening of Anesthesia Care Providers and Ancillary Support Personnel

- The anesthesiologist should work in collaboration with the MRI medical director or designee (e.g., safety officer) to ensure that all anesthesia team personnel entering zone III or IV have been screened for the presence of ferromagnetic materials, foreign bodies, or implanted devices.

III. Patient Screening

- For every case, the anesthesiologist should communicate with the patient, referring physician, and radiologist to determine whether the patient:
  - Presents with a high-risk medical condition (e.g., neonatal status or prematurity; intensive or critical care status; impaired respiratory function; hemodynamic instability and vasoactive infusion requirements; or comorbidities such as obesity and peripheral vascular disease)
  - Requires equipment (e.g., physiologic or invasive monitors; intubation, oxygenation, or ventilation equipment)
  - Has been screened for implanted devices (e.g., pacemakers, cardioverter defibrillators, or nerve stimulators)
  - Has been screened for implanted ferromagnetic items (e.g., surgical clips and prosthetic heart valves)
  - Has been screened for the presence of imbedded foreign bodies (e.g., orbital iron filings and eyeliner tattoos)
- The anesthesiologist should communicate with the technologist to ensure that the patient has been screened for the presence of foreign bodies on the patient (e.g., pierced jewelry, rings) before entering zone III.
- If a patient presents with high-risk medical condition, the anesthesiologist should collaborate with all participants, including the referring physician, radiologist, and technologist, to determine how the patient will be managed during the MRI procedure.
  - Anticipated changes in level of sedation, muscle relaxation, or ventilation may also place a patient in a high-risk situation.
- For patients with acute or severe renal insufficiency, the anesthesiologist should not administer gadolinium because of the elevated risk of nephrogenic systemic fibrosis.
- Anesthesiologists should work with their institutions to properly identify and label anesthesia-related equipment according to convention (safe, unsafe, or conditional) for each MRI scanner.
- For each MRI location, anesthesiologists should determine the safety and effectiveness of the equipment needed by the patient during the procedure.
  - Care should be taken to assure that the patient's equipment does not interfere with image acquisition or quality.
- Cardiac pacemakers and implantable cardioverter-defibrillators are generally contraindicated for MRI.
  - When MRI is considered essential by the referring physician and consulting radiologist, a plan for managing these patients during the scan should be developed in collaboration with the ordering physician, medical director, or on-site radiologist and other appropriate consultants (e.g., the patient's pacemaker specialist or cardiologist, the diagnostic radiologist, and the device manufacturer).
- MRI may be performed on a limited basis for patients with certain implanted electronic devices (e.g., deep brain stimulators, vagal nerve stimulators, phrenic nerve stimulators, wire-containing thermodilution catheters, or cochlear implants).
  - In consultation with the referring physician, the radiologist responsible for the procedure, and the neurosurgeon, the anesthesiologist should ensure that the presence of the device has been noted and determined to be MRI safe/conditional before imaging of these patients.

IV. Preparation

- For every case, the anesthesiologist should prepare, with support personnel, a plan for providing optimal anesthetic care within the special environment of the MRI suite.
  - In addition to addressing the medical needs of the patient, features of the plan should include (1) requirements of the scan and personnel needs, (2) positioning of equipment, (3) special requirements or unique issues of patient or imaging study, (4) positioning of the anesthesiologist and the patient, and (5) planning for emergencies.
- The anesthesiologist should communicate with the radiology personnel to determine the requirements for the scan (e.g., duration of the scan, position of the patient or area of the body in the scanner, positioning of receiver coils, and need for periods of paused respiration).
- The anesthesiologist should communicate with other anesthesia team members regarding individual roles for anesthetic care.
- The anesthesiologist should collaborate with the MR technologist and/or facility biomedical engineer to determine and demarcate the optimal and safe location of movable equipment in relation to the gauss lines within the MRI suite.

- The anesthesiologist should choose a location or position for optimal patient observation and vigilance during delivery of care, whether in zone III or IV.
    - Anesthesiologists should have (1) a clear line of sight of the patient and physiologic monitors, whether by direct observation or by video camera, (2) anesthetic delivery equipment located for optimal control of anesthetic depth and rapid intervention, and (3) access to hospital information systems integral to patient care.
    - In preparing for positioning, the anesthesiologist should take into account potential electromagnetic and auditory hazards.
- Anesthesiologists should prepare a plan for rapidly summoning additional personnel in the event of an emergency.
    - The anesthesiologist should ensure that (1) emergency equipment and drugs are immediately accessible, (2) emergency communication (e.g., phone or code button) is immediately available, and (3) an evacuation plan is in place, including an appropriate location outside the scan room (zone IV) for resuscitation.
- This location should be complete with physiologic monitors, oxygen, suction, and other appropriate resuscitation equipment.

V. Patient Management during MRI

- Monitoring
    - MRI patients should be monitored in a manner consistent with the American Society of Anesthesiologists (ASA) "Standards for basic anesthesia monitoring."
    - The anesthesiologist should be familiar with the expected limitations of available monitoring equipment.
- Information from electrocardiograms may be limited due to superimposed voltages from blood flow in the high magnetic field (e.g., ST segment interpretation may be unreliable, even with highly filtered monitors).
    - The anesthesiologist should make sure that all monitors used in zone IV are safe/conditional for the scan.
    - A monitor should be available to view vital signs from zone III when the anesthesia care provider is not in zone IV.
    - Additional care should be taken in positioning electrocardiogram and other monitor leads to eliminate burns, even with nonferromagnetic leads.
- Anesthetic care
    - Although lighter levels of anesthesia may be appropriate during an MRI scan, the anesthesiologist should be aware that these lighter levels may result in airway complications (e.g., laryngospasm, coughing, or other airway compromise) which may necessitate interruption of the scan for urgent treatment and alteration of anesthetic depth.
- Institutional circumstances, patient characteristics, and anesthesiologist preference may warrant more aggressive airway management and deeper anesthetic levels.
    - Anesthesiologists should ensure that patients who receive moderate or deep sedation are monitored in a manner consistent with their institution's protocol for monitoring similarly sedated patients elsewhere in the facility.
    - Monitoring of exhaled carbon dioxide should be considered for all patients receiving deep sedation and for patients whose ventilation cannot be directly observed during moderate sedation.
    - Monitoring oxygenation by pulse oximetry is not a substitute for monitoring ventilatory function.
    - Equipment and drugs for anesthetic care in the MRI suite should mirror what is available in other anesthetizing locations including: (1) an integrated anesthesia machine, medical gases, and waste anesthesia gas disposal or gas scavenging, when inhalational anesthesia is administered, (2) suction, (3) adequate electrical outlets and lighting, and (4) storage areas for equipment and drugs.
    - Equipment used in the MRI suite should be appropriate for the age and size of the patient.
    - MRI safe/conditional anesthesia machines are always preferred for use in an MRI facility.
- When an MRI safe/conditional anesthesia machine is not available, inhalational anesthetics can be administered from an anesthesia machine inside zone III via an elongated circuit through a wave guide.
- If total intravenous anesthesia is used, it should be administered by using (1) MRI safe/conditional pumps in zone IV, (2) traditional (i.e., MRI unsafe) pumps in zone III with intravenous tubing passed through a wave guide, or (3) periodic bolus injections in either zone III or IV.
- Although an anesthesia machine may not be required for the administration of total intravenous anesthesia, there must be equipment immediately available for the administration of positive pressure ventilation with oxygen.
- Airway management
    - The anesthesiologist should have an advance plan in place to deal with instrumentation of the airway and common airway problems (e.g., obstruction, secretions, laryngospasm, apnea, and hypoventilation) when patients are in an MRI environment.
    - If the patient is at risk for airway compromise, more aggressive airway management (e.g., use of a tracheal tube or laryngeal mask airway), should be instituted because the patient's airway may be less accessible when the patient is in the scanner.
    - Complex airway management (e.g., fiberoptic intubation) should be performed in a controlled environment outside zone IV.
    - Alternative airway devices should be immediately available in the MRI suite.
    - Suction equipment should be immediately accessible to the patient's airway at all times.

VI. Management of Emergencies
- When a patient has a medical emergency (e.g., cardiopulmonary arrest) in the MRI scanner, the following should occur: (1) immediately remove the patient from zone IV while initiating cardiopulmonary resuscitation (CPR), if indicated, (2) call for help, and (3) transport the patient to a previously designated safe area for resuscitation that is not in zone IV.
  - This location should be as close to zone IV as possible so as not to delay resuscitation efforts and should contain the following resuscitation equipment: a defibrillator, vital signs monitors, and a code cart that includes resuscitation drugs, airway equipment, oxygen, and suction.
- When a fire occurs in the MRI suite, team members should perform their preassigned fire management task as quickly as possible, in accordance with the ASA practice advisory for the prevention and management of operating room fires.
  - If a team member cannot rapidly perform his or her task in the predetermined order, other team members should perform their tasks without waiting.
  - When a team member has completed a preassigned task, he or she should help other members perform tasks that are not yet complete.
- In the case of projectile emergencies, team members should perform their institution's protocol in reaction to this occurrence.
  - If possible, immediately remove the patient from zone IV and discontinue the scan.
  - If the patient is injured, proceed with medical emergency management as indicated above.
  - A controlled quench may be necessary in order to remove the patient from the bore.
- When a quench occurs, team members should perform their institution's protocol in reaction to this occurrence. If possible: (1) immediately remove the patient from zone IV and (2) immediately administer oxygen to the patient.
  - Powerful static magnetic fields may persist after a quench, and therefore, the usual precautions apply when entering zone IV.
- Emergency response personnel should be restricted from entering zone IV during any environmental emergency because of the persistent magnetic field.

VII. Postprocedure Care
- The anesthesiologist should collaborate with the radiologist and other staff in the postprocedure care of the patient.
- Patients receiving sedation or anesthesia within the MRI suite should have access to postanesthetic care consistent with that provided in other areas of the institution, including transport to other recovery rooms, dedicated intensive care, or recovery areas within the MRI suite.
- In all situations, intensive care and recovery areas should include access to vital sign monitors, oxygen, suction, resuscitation equipment, and trained personnel.
- Patients should be provided oral and written discharge instructions.

Zone Definitions

Zone III

This area is the region in which free access by unscreened non-MR personnel or ferromagnetic objects or equipment can result in serious injury or death as a result of interactions between the individuals or equipment and the MR scanner's particular environment. These interactions include, but are not limited to, those with the MR scanner's static and time varying magnetic fields. All access to zone III is to be strictly restricted, with access to regions within it (including zone IV; see below) controlled by, and entirely under the supervision of, MR personnel.

Zone IV

This area is synonymous with the MR scanner magnet room itself. Zone IV, by definition, will always be located within zone III as it is the MR magnet and its associated magnetic field, which generates the existence of zone III.

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Diseases or conditions requiring magnetic resonance imaging (MRI)

Guideline Category

Management

Prevention

Risk Assessment

Screening

Clinical Specialty

Anesthesiology

Critical Care

Nuclear Medicine

Nursing

Radiology

Intended Users

Advanced Practice Nurses

Allied Health Personnel

Hospitals

Nurses

Physician Assistants

Physicians

Guideline Objective(s)

- To promote patient and staff safety in the magnetic resonance imaging (MRI) environment
- To prevent the occurrence of MRI-associated accidents
- To promote optimal patient management and reduce adverse patient outcomes associated with MRI
- To identify potential equipment-related hazards in the MRI environment
- To identify limitations of physiologic monitoring capabilities in the MRI environment
- To identify potential health hazards (e.g., high decibel levels) of the MRI environment

Target Population

Patients receiving anesthetic care for magnetic resonance imaging (MRI)

Note: This Advisory does not address specific anesthetic drug choices and does not apply to patients who receive minimal sedation (anxiolysis) in order to complete the scan or procedure safely and comfortably.

Interventions and Practices Considered

Education

1. General safety education on the unique physical environment of the magnetic resonance imaging (MRI) scanner

2. Specific education regarding the specific features of individual scanners
3. Anesthesiologist collaboration with radiologists, technologists, and physicists on safety training programs
4. Education on code blue situations in zones III and IV

Patient/Personnel Screening

1. Anesthesiologist collaboration with MRI medical director or designee to screen anesthesia team personnel for the presence of ferromagnetic materials, foreign bodies, or implanted devices
2. Screening for patient-related risks for adverse outcomes related to MRI
3. Assessing equipment-related risks for adverse outcomes related to MRI

Management

1. Planning for the optimal anesthetic care of the patient for the scan
2. Communication of the requirements for the scan (duration, position, positioning of receiver coils)
3. Communication of individual roles and determination of optimal locations for movable equipment and patient observation
4. Planning for rapidly summoning additional personnel in the event of an emergency
5. Patient monitoring during MRI (vital signs, electrocardiogram)
6. Anesthetic care during MRI (oxygenation, anesthesia machines)
7. Airway management
8. Management of medical and environmental emergencies
9. Postprocedure care consistent with that provided for other areas of the institution

Major Outcomes Considered

- Incidence of airway complications during magnetic resonance imaging (MRI)
- Incidence of medical or environmental problems or emergencies
- Patient mortality or morbidity

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Scientific evidence used in the development of this updated Advisory is based on cumulative findings from literature published in peer-reviewed journals. Literature citations are obtained from PubMed and other healthcare databases, direct Internet searches, Task Force members, liaisons with other organizations, and manual searches of references located in reviewed articles.

State of the Literature

For this updated Advisory, a review of studies used in the development of original Advisory was combined with studies published subsequent to approval of the original Advisory in 2009. The scientific assessment of this updated Advisory was based on evidence linkages or statements regarding potential relationships between patient care interventions and safety outcomes in the magnetic resonance imaging (MRI) suite. The evidence linkage interventions are listed in Appendix 3 in the original guideline document.

For the literature review, potentially relevant studies were identified via electronic and manual searches of the literature. The updated searches covered a 7-yr period from 2008 through 2014. Over 200 new citations that addressed topics related to the evidence linkages were identified.

These articles were reviewed and those meeting the appropriate criteria as outlined in the "Focus" section of the guidelines were combined with pre-2009 articles used in the original Advisory, resulting in a total of 183 articles that contained direct linkage-related evidence. A complete bibliography used to develop these Guidelines, organized by section, is available (see the "Availability of Companion Documents" field).

Number of Source Documents

A total of 183 articles contained direct linkage-related evidence.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Scientific Evidence

Findings from the aggregated literature are reported in the text of the Advisory by evidence category, level, and direction. Evidence categories refer specifically to the strength and quality of the *research design* of the studies. Category A evidence represents results obtained from randomized controlled trials (RCTs), and Category B evidence represents observational results obtained from nonrandomized study designs or RCTs without pertinent controls. When available, Category A evidence is given precedence over Category B evidence in the reporting of results. These evidence categories are further divided into evidence levels. Evidence levels refer specifically to the strength and quality of the summarized study findings (i.e., statistical findings, type of data, and the number of studies reporting/replicating the findings) within the two evidence categories. For this document, only the highest level of evidence is included in the summary report for each intervention, including a directional designation of benefit, harm, or equivocality for each outcome.

Category A

RCTs report comparative findings between clinical interventions for specified outcomes. Statistically significant ($P<0.01$) outcomes are designated as either beneficial (B) or harmful (H) for the patient; statistically nonsignificant findings are designated as equivocal (E).

Level 1: The literature contains a sufficient number of RCTs to conduct meta-analysis,* and meta-analytic findings from these aggregated studies are reported as evidence. No meta-analyses were conducted for this Advisory.

Level 2: The literature contains multiple RCTs, but the number of RCTs is not sufficient to conduct a viable meta-analysis for the purpose of this updated Advisory. Findings from these RCTs are reported as evidence.

Level 3: The literature contains a single RCT, and findings from this study are reported as evidence.

Category B

Observational studies or RCTs without pertinent comparison groups may permit *inference* of beneficial or harmful relationships among clinical interventions and outcomes. Inferred findings are given a directional designation of beneficial (B), harmful (H), or equivocal (E). For studies that report statistical findings, the threshold for significance is $P<0.01$.

Level 1: The literature contains observational comparisons (e.g., cohort, case-control research designs) between clinical interventions for a specified outcome.

Level 2: The literature contains observational studies with associative statistics (e.g., relative risk, correlation, and sensitivity/specificity).

Level 3: The literature contains noncomparative observational studies with descriptive statistics (e.g., frequencies and percentages).

Level 4: The literature contains case reports.

Insufficient Literature

The *lack* of sufficient scientific evidence in the literature may occur when the evidence is either unavailable (i.e., no pertinent studies found) or inadequate. Inadequate literature cannot be used to assess relationships among clinical interventions and outcomes because such literature does not permit a clear interpretation of findings due to methodological concerns (e.g., confounding in study design or implementation) or does not meet the

criteria for content as defined in the "Focus" of the Advisory.

Opinion-based Evidence

The original Advisory contained formal survey information collected from expert consultants and a random sample of members of the American Society of Anesthesiologists (ASA). Additional information was obtained from open-forum presentations and other invited and public sources. All opinion-based evidence relevant to each topic (e.g., original survey data, original open-forum testimony, Internet-based comments, letters, and editorials) is considered in the development of this Advisory. However, only the findings obtained from formal surveys are reported.

Opinion surveys were developed by the Task Force to address each clinical intervention identified in the document. Identical surveys were distributed into two groups of respondents: expert consultants and ASA members.

Expert Opinion

Survey responses from Task Force-appointed expert consultants are reported in summary form in the text of the original guideline document. A complete listing of consultant survey responses is reported in Table 1 in Appendix 3 of the original guideline document.

Membership Opinion

Survey responses from a random sample of members of the ASA and, when appropriate, responses from members of other organizations with expertise in the selected topics of interest are reported in summary form in the text of the original guideline document. A complete listing of ASA member survey responses is reported in Table 2 in Appendix 3 of the original guideline document.

Survey responses are recorded using a 5-point scale and summarized based on median values.**

Strongly Agree: Median score of 5 (at least 50% of the responses are 5)

Agree: Median score of 4 (at least 50% of the responses are 4 or 4 and 5)

Equivocal: Median score of 3 (at least 50% of the responses are 3, or no other response category or combination of similar categories contain at least 50% of the responses)

Disagree: Median score of 2 (at least 50% of responses are 2 or 1 and 2)

Strongly Disagree: Median score of 1 (at least 50% of responses are 1)

Informal Opinion

Open-forum testimony, Internet-based comments, letters, and editorials are all informally evaluated and discussed during the development of the Advisory. When warranted, the Task Force may add educational information or cautionary notes based on this information.

*All meta-analyses are conducted by the ASA/Committee on Standards and Practice Parameters (CSPP) methodology group. Meta-analyses from other sources are reviewed but not included.

**When an even number of responses are obtained, the median value is determined by calculating the arithmetic mean of the two middle values. Ties are calculated by a predetermined formula.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review

Description of the Methods Used to Analyze the Evidence

No evidence linkage contained enough studies with well-defined experimental designs and statistical information to conduct a quantitative analysis (i.e., meta-analysis).

For the original Advisory, interobserver agreement among Task Force members and two methodologists was established by interrater reliability testing. Agreement levels using a κ statistic for two-rater agreement pairs were as follows: (1) type of study design, κ=0.49 to 0.85; (2) type of

analysis, κ=0.54 to 0.93; (3) evidence linkage assignment, κ=0.77 to 1.00; and (4) literature inclusion for database, κ= 0.78 to 1.00. Three-rater chance-corrected agreement values were (1) study design, Sav=0.65, Var (Sav)=0.009; (2) type of analysis, Sav=0.69, Var (Sav)=0.010; (3) linkage assignment, Sav=0.85, Var (Sav)=0.004; and (4) literature database inclusion, Sav=0.85, Var (Sav)=0.013. These values represent moderate to high levels of agreement.

Consensus-based Evidence

For the original Advisory, consensus was obtained from multiple sources, including (1) survey opinion from consultants who were selected based on their knowledge or expertise in magnetic resonance imaging (MRI), (2) survey opinions solicited from active members of the American Society of Anesthesiologists (ASA), (3) testimony from attendees of a publicly held open forum at two national anesthesia meetings, (4) Internet commentary, and (5) Task Force opinion and interpretation. The survey rate of return was 63% (n=50 of 79) for the consultants, and 989 surveys were received from active ASA members. Results of the surveys are reported in Tables 1 and 2 and in the text of the Advisory.

The consultants were asked to indicate which, if any, of the evidence linkages would change their clinical practices if the Advisory was instituted. The rate of return was 29% (n=23 of 79). The percent of responding consultants expecting a change in their practice associated with each linkage topic was as follows: (1) education, 30%; (2) screening of anesthesia care providers and ancillary support personnel, 13%; (3) patient screening, 26%; (4) preparation, 13%; (5) patient management during MRI: monitoring, 4%; (6) patient management during MRI: anesthetic care, 0%; (7) patient management during MRI: airway, 0%; (8) patient management during MRI: emergencies, 13%; and (9) postprocedure care, 9%. Seventy-four percent indicated that their clinical practice will not need new equipment, supplies, or training in order to implement the Practice Advisory. Eighty-five percent indicated that the Advisory would not require ongoing changes in their practice which will affect costs. Ninety-five percent of the respondents indicated that the Advisory would have *no effect* on the amount of time spent on a typical case, and 5% indicated that there would be a 10-min increase in the amount spent on a typical case with the implementation of this Advisory.

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Task Force Members and Consultants

In 2013, the American Society of Anesthesiologists (ASA) Committee on Standards and Practice Parameters requested that scientific evidence for this Advisory be updated. The update consists of an evaluation of literature that includes new studies obtained after publication of the original Advisory.

The original Advisory was developed by an ASA-appointed Task Force of 13 members. These individuals included 10 anesthesiologists in private and academic practice from various geographic areas of the United States, a radiologist, and two consulting methodologists from the ASA Committee on Standards and Practice Parameters.

The Task Force developed the original Advisory by means of a seven-step process. First, they reached consensus on the criteria for evidence. Second, a systematic review and evaluation was performed on original published research studies from peer-reviewed journals relevant to magnetic resonance imaging (MRI) safety. Third, a panel of expert consultants was asked to: (1) participate in opinion surveys on the effectiveness of various MRI safety strategies and (2) review and comment on a draft of the Advisory developed by the Task Force. Fourth, opinions about the Advisory were solicited from a random sample of active members of the ASA. Fifth, the Task Force held an open forum at two major national meetings* to solicit input on its draft recommendations. Sixth, the consultants were surveyed to assess their opinions on the feasibility of implementing this Advisory. Seventh, all available information was used to build consensus within the Task Force to create the final document. A summary of recommendations is found in Appendix 2 of the original guideline document.

*International Anesthesia Research Society, 82nd Clinical and Scientific Congress, San Francisco, California, March 30, 2008; Society for Pediatric Anesthesia, Annual Meeting; San Diego, California, April 5, 2008.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

The updated guideline was approved by the American Society of Anesthesiologists (ASA) House of Delegates on October 15, 2014.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

Evidence was obtained from two principal sources: scientific evidence and opinion-based evidence.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Because the safe conduct of magnetic resonance imaging (MRI) procedures requires close collaboration and prompt coordination between anesthesiologists, radiologists, MRI technologists, and nurses, some responsibilities are shared among the disciplines. When shared responsibilities are described in this Advisory, the intent is to give the anesthesiologist a starting point for participating in the allocation and understanding of shared responsibilities. The Advisory may also serve as a resource for other physicians and healthcare professionals (e.g., technologists, nurses, safety officers, hospital administrators, biomedical engineers, and industry representatives).

Potential Harms

The magnetic resonance imaging (MRI) suite is a hazardous location because of the presence of a very strong static magnetic field, high-frequency electromagnetic (radiofrequency) waves, and a time-varied (pulsed) magnetic field. Secondary dangers of these energy sources include high-level acoustic noise, systemic and localized heating, and accidental projectiles. There may be significant challenges to anesthetic administration and monitoring capabilities due to static and dynamic magnetic fields as well as radiofrequency energy emissions. Direct patient observation may be compromised by noise, darkened environment, obstructed line of sight, and other characteristics unique to this environment (e.g., distractions). Unlike a conventional operating room, the MRI environment frequently requires the anesthesiologist to assume broader responsibility for immediate patient care decisions.

Contraindications

Contraindications

- The Task Force believes that cardiac pacemakers and implantable cardioverter-defibrillators are generally contraindicated for magnetic resonance imaging (MRI). These devices pose an extreme hazard in this environment and may be life-threatening within the 5 gauss line.
- Other implanted electronic devices also pose a hazard in the MRI environment. These devices and associated wiring may transfer energy during the MRI scan, causing tissue damage, malfunction of the device, image artifacts, and device displacement. MRI may be performed on a limited basis for patients with certain implanted electronic devices (e.g., deep brain stimulators, vagal nerve stimulators, phrenic nerve

stimulators, wire-containing thermodilution catheters, or cochlear implants).

Qualifying Statements

Qualifying Statements

- Practice advisories are systematically developed reports that are intended to assist decision-making in areas of patient care. Advisories provide a synthesis and analysis of expert opinion, clinical feasibility data, open forum commentary, and consensus surveys. Practice advisories developed by the American Society of Anesthesiologists (ASA) are not intended as standards, guidelines, or absolute requirements and their use cannot guarantee any specific outcome. They may be adopted, modified, or rejected according to clinical needs and constraints and are not intended to replace local institutional policies.
- Practice advisories are not supported by scientific literature to the same degree as standards or guidelines because of the lack of sufficient numbers of adequately controlled studies. Practice advisories are subject to periodic revision as warranted by the evolution of medical knowledge, technology, and practice.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Staying Healthy

IOM Domain

Safety

Identifying Information and Availability

Bibliographic Source(s)

American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Practice advisory on anesthetic care for magnetic resonance imaging: an updated report by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Anesthesiology. 2015 Mar;122(3):495-520. [146 references] PubMed

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2009 Mar (revised 2015 Mar)

Guideline Developer(s)

American Society of Anesthesiologists - Medical Specialty Society

Source(s) of Funding

American Society of Anesthesiologists

Guideline Committee

Task Force on Anesthetic Care for Magnetic Resonance Imaging

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

The authors declare no competing interests.

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging, Ehrenwerth J, Singleton MA, Bell C, Brown JA, Clark RM, Connis RT, Herfkens R, Litt L, Mason KP, McClain CD, Nickinovich DG, Ryan SM, Sandberg WS. Practice advisory on anesthetic care for magnetic resonance imaging. A report by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Anesthesiology. 2009 Mar;110(3):459-79. [130 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the Anesthesiology Journal Web site .

Availability of Companion Documents

The following is available:

- Practice advisory on anesthetic care for magnetic resonance imaging: an updated report by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Bibliography. 2015. 14 p. Available from the Anesthesiology Journal Web site .

Patient Resources

None available

NGC Status

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